Hypothesis Testing

Notes

- Central concept in statistical reasoning and thinking
- Increase confidence in the findings of research
- Often tests claims about the "true" mean (or any other population parameter)

Logic of hypothesis testing

- H_0: The finding was simply a chance occurrence (null version) – very little really occurred
- H_1:The finding did not occur by chance but is real (alternative version) – something beyond chance variation did occur

Logic of hypothesis testing - continued

- We test hypothesis by trying to disprove the null hypothesis
- We assume the null hypothesis to be true unless we find evidence to the contrary – then we assume the alternative hypothesis is more likely to be correct
- The probability of something occurring equal to or less than 0.05 is considered the border line for "unlikely".

Null Hypothesis

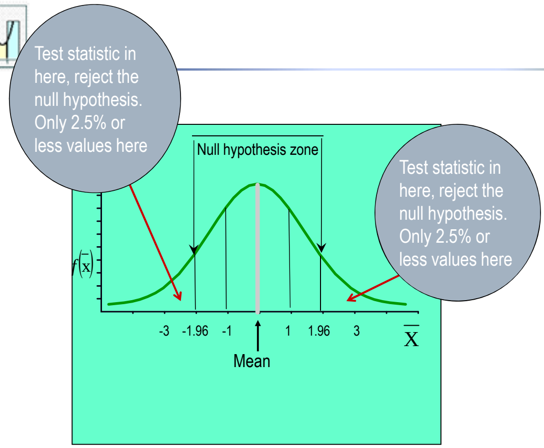
- Is the actual statement that is tested
- Always has equality sign: $=$, $\leq$, or $\geq$
- Designated H_0
  - Pronounced 'H sub-zero' or 'H oh'
- Examples
  - H_0: $\mu \geq 3$
  - H_0: $\mu \leq 3$
  - H_0: $\mu = 3$

Alternative Hypothesis

- Opposite of null hypothesis
- Always has inequality sign: $\neq$, $<$, or $>$
- Designated H_1
- Example
  - H_1: $\mu < 3$
  - H_1: $\mu > 3$
  - H_1: $\mu \neq 3$

Level of Significance

- Defines unlikely values of sample statistic if null hypothesis is true
  - Called rejection region of sampling distribution
- Designated α (alpha) (or p-value)
  - Typical values are .01, .05, .10
- Selected by researcher at start
- If the calculated p-value is 0.05 or less, we can reject the null hypothesis that the occurrence is simply a chance occurrence



What are one-tailed and two-tailed tests?

- Two-tailed test:
  - H_0: $\mu = 10$
    We reject for too small or too large values of sample average
- One-tailed test:
  - H_0: $\mu \leq 10$
    We only reject for too large values of sample average
  - H_0: $\mu \geq 10$
    We only reject for too small values of sample average

Risk of Errors in Making Decision Type I error

- Rejecting the true null hypothesis
- Has serious consequences
- Probability of Type I error is α
  - Called level of significance

Risk of Errors in Making Decision Type II error

- Not rejecting false null hypothesis
- Probability of Type II error is β (Beta)
  - Called Power of the test ($1 - \beta$)

Decision Results

H_0: Innocent

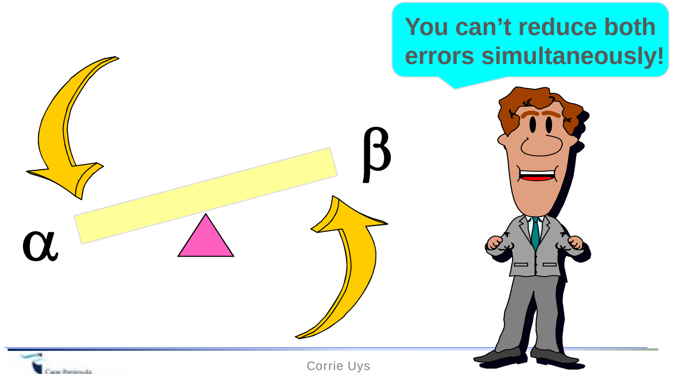
Jury Trial

Verdict	Actual Situation: Innocent	Actual Situation: Guilty
Innocent	Correct	Error
Guilty	Error	Correct

H_0 Test

Decision	Actual Situation: H_0 True	Actual Situation: H_0 False
Do Not Reject H_0	$1 - \alpha$	Type II Error (β)
Reject H_0	Type I Error (α)	Power ($1 - \beta$)

α & β Have an Inverse Relationship



Factors Affecting β

- True value of population parameter
  - β increases when difference with hypothesized parameter decreases
- *Significance level, α*
  - *β Increases when α decreases*
- Population standard deviation, σ
  - β Increases when σ increases
- *Sample size, n*
  - *β decreases when n increases*

Hypothesis Testing Steps

- State H_0 and H_1
- Choose α
- Determine *n*
- Choose test
- Collect and capture data
- Run statistical tes
- Compare the p-value calculated by test with α
- Make statistical conclusion
- Express conclusion in terms of actual problem

Some considerations when choosing a statistical analysis technique - 1

Number of variables:
- → One → Univariate
- → Two → Bi-variate
- → Three → Multivariate

Level of measurement
- → Nominal or Ordinal (Categorical or Qualitative data)
- → Interval or Ratio (Numerical data).

Some considerations when choosing a statistical analysis technique - 2

Sample size:
- Large ($n > 30$) → Parametric techniques
- Small ($n < 30$) → Non-parametric techniques

Number of groups:
- One
- Two
  - Independent
  - Dependent (paired)
- Three or more.

Some considerations when choosing a statistical analysis technique - 3

Testing hypotheses about means and proportions and determining dependencies.

		One Group	Two Groups: Independent	Two Groups: Dependent	More than two groups
Hypothesis about central tendency	Parametric	σ^2 known: z σ^2 unknown: t	t	Paired t	ANOVA
	Non-Parametric	No test	Mann-Whitney	Wilcoxon	Kruskall-Wallis
	Frequency Data	χ^2 or z	χ^2 or z	χ^2 (McNemar)	χ^2
Hypothesis about association	Parametric Assumptions	t	z		
	Frequency Data	χ^2			

Some considerations when choosing a statistical analysis technique - 4

Types of correlations for different measurement levels:

	Nominal	Ordinal	Interval or Ratio
Nominal	Phi		
Ordinal		Spearman's r	
Interval or Ratio			Pearson's r

r = correlation coefficient

Some considerations when choosing a statistical analysis technique - 5

Association:

Numerical data

Two variables (1 independent): Linear regression

More than two variables (1 independent): Multiple Regression

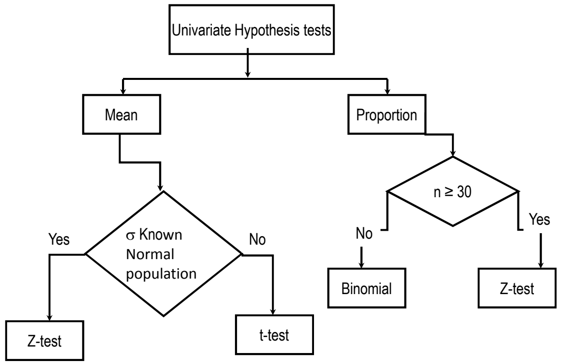
Categorical data

Two or more variables (1 independent): Logistic regression

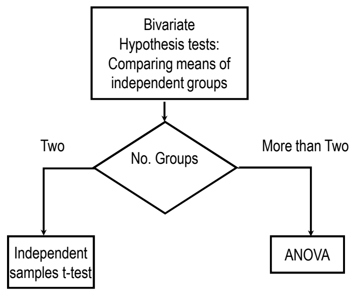
Multiple dependent variables

Multivariate techniques (factor analysis, principal component's analysis, correspondance analysis, cluster analysis)

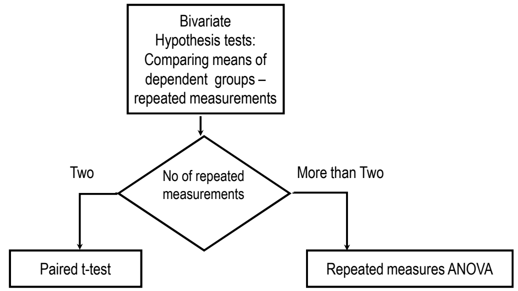
Which test to choose – univariate statistics?



Comparing Group means: Independent groups



Comparing Group means: Dependent (Paired) groups



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